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Preparation of Tasty Vegetable Products by Deep-Fat Frying[a]

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Tasty vegetable chips, similar to potato chips, have been made from beets, carrots and parsnips. Deep-fat fried pea and lima bean embryo chunks have been prepared from overmature canning or freezing varieties of peas and lima beans and these had a delectable nut-like flavor. The best conditions of cooking (time, temperature and slice thickness) have been worked out for these products. The five vegetable items have been evaluated by both small and large informal taste panel groups for product quality and possible application. Although there were individual preferences for one product or another, on the whole they were greatly relished by the tasters and considered readily acceptable for snack items or fresh vegetable substitutes in a meal. A cooking oil of high stability gave products which retained their high quality after months of storage.

The oil contents and yields of the fried vegetables have been found and a method of partial degreasing has been proposed. Crude protein values have also been determined. Fried peas and lima beans are highly nutritious food items with about 20% protein and 30% oil contents. Carotene studies made on fresh and fried carrot slices showed carotene losses on frying but the fried slices were still very rich in this pro-vitamin A factor.

Ground peas or lima beans with smoked flavoring ingredients made excellent soup mixes which could be readily rehydrated in about 3 minutes.

The trend in food usage today is toward the precooked or prepared package that requires a minimum of cooking time on the part of the housewife. The great increase in the consumption of vegetables in frozen packs and the phenomenal development of the potato chip industry in the past ten years are two of the primary examples of this trend. It occurred to members of the technical staff of this laboratory that other vegetables besides potatoes might be processed in a similar manner to provide a palatable precooked product having the same appeal to the busy housewife.

Certain seeds and beans have been on the market in fat fried form for a number of years, but these products appear to be a result of national preferences that have come to this country from other lands. An example of this type is the fat fried ceci bean common in the Italian markets. Some vegetables are familiar snack items in every grocery store but in forms little resembling the original vegetable. Corn is the vegetable most used for this purpose but onion- or parsley-flavored carbohydrate mixtures have appeared on a more limited scale. Sweet potato chips have been prepared commercially by firms in the southern growing region and more recently in Denver *(7)* and it is claimed that these chips are very acceptable provided they are made from a newly developed variety of sweet potato *(1)*.

We have been told (personal communication) that tasty chips can be made from bananas, particularly the starchy one known as the plantain.

In the study of French fried vegetables carried on at this laboratory a preliminary survey was made on 12 vegetables. Of these, 5 showed real promise as acceptable food items. These were beets, carrots, and parsnips in sliced form and peas and lima beans in whole or seed form.

The various factors required for the preparation of successful chips and bean and pea chunks have been studied, and their acceptance by both large and small group taste panels has been investigated.

Variety, maturity, thickness of slice, time and temperature of cooking, and the type of oil used for the deep-fat frying are the factors influencing the final character of the finished product. These factors varied for each of the vegetables and it was necessary to study each separately.

When a product was prepared under a number of varying conditions, a small group of colleagues were invited to express an opinion on which condition they considered most satisfactory from the standpoint of taste and texture. The taste was largely a question of, "did they like it or not?," and the texture was one of crispness as against toughness or chewiness.

After the appraisal by the small laboratory group the conditions were selected for the preparation of quantities of chips, peas, and lima beans for large scale group tasting. Two groups, of about 300 people each, were served the various products and their preferences noted.

We also attempted to determine whether or not these people would be interested in buying the products on the market and for what purpose they might want to use them, i.e., as a vegetable, as a cocktail snack, or for use as a general food snack like salted nuts.

In studying the physical characteristics of the chips and bean and pea chunks, it was noted that they rehydrated in hot water within a few minutes and became as soft and pliable as a cooked vegetable. This led to the discovery that these deep-fat fried vegetable pieces might have possibilities for dehydrated soup mixes. We have made up a number of such soups from ground chips, peas, or peas and carrots with added flavoring and have submitted them to our small taste panel groups for appraisal.

Storage studies. Storage studies have been made on the 5 products under investigation. Since the oil used for the deep-fat frying was very stable, no question of rancidity of the oil was involved. The chips and peas

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and lima beans were stored in air tight jars in the dark at an average room temperature of 70° F. Changes in odor and taste were noted after varying storage periods. The results are presented under each vegetable studied.

EXPERIMENTAL PROCEDURES AND RESULTS

Preparation of vegetable chips. Beets, carrots and parsnips were sliced to 1/32-1/16 in. thickness with a standard rotary knife slicer manufactured by the Eagle Machine and Tool Company, Springfield, Ohio, Model 20 c.[c] This cutter was easily adjustable to slice at any thickness but the adjustment had to be checked with a micrometer gauging of the cut slice.

The deep fat fryer used in this study was a Hotpoint Fry Kettle Model HK3[c] having a capacity of 15 lbs. of fat. This model is available with either one or two baskets for holding the food product. We found both sizes very useful for different size batches. In most of this work ½ lb. lots of vegetables were fried in the smaller baskets and 1 lb. lots were fried in the larger one. The Calrod[c] heater of this fryer quickly brought the temperature of the hot oil to the thermostat setting required for each experiment even with the larger quantity of vegetable.

In an experimental study of the frying of new types of vegetable products, the type of fat used is of great importance. In our early experiments we used a hydrogenated or shortening type oil but this proved to be unsatisfactory because of the high melting point of the product. Because it was necessary to prepare our vegetable chips at lower temperatures than those normally used for potato chips the amount of oil absorbed by the products was somewhat higher. We found that the higher melting point oils tended to solidify on the surface of the product after a few days at room temperature. This solidified fat detracted from the quality of the finished vegetable from the standpoint of both appearance and taste.

At about the time our experimental work was starting on these vegetable products a new fat was introduced to the potato chip trade. This was called to our attention by a commercial chipper and we obtained a quantity for our experimental studies. The product is a modified coconut oil known to the trade as "Dri-Fri" manufactured by the E. F. Drew and Company, Inc., of Boonton, New Jersey.[c]

Two factors have influenced the suitability of this oil for our experimental studies. First, the oil does not precipitate on the surface of the product at ordinary room temperatures. Second, the oil is stable against oxidative rancidity for long periods of time both on the shelf and in the fried product. We have so far failed to detect any off-flavor due to rancidity in any of our fried products even though many of these are well over a year old at this time.

We are not in a position to predict how much this oil would be used for the commercial preparation of French fried vegetable products since economic factors unknown to us might influence its use. Its high degree of stability should be of real importance, particularly with peas and lima beans which might be canned for snack items or soup mixes and be held on the grocery shelf for long periods of time.

Peas and lima beans were also fried in modified coconut oil containing 0.13% of the antioxidant "Sustane"[c] which has been used successfully to inhibit the development of rancidity in potato chips.

After 9 months' storage in air tight glass jars kept at room temperature (70° F.) in a dark cabinet no rancidity could be detected in any of the products by our taste panel members. Even longer periods of storage showed no appreciable differences between the treated and the untreated products.

With the beet, carrot and parsnip chips which would probably be marketed within a few weeks after their preparation, other types of commercially available oils such as peanut, corn or cottonseed would probably be as satisfactory as "Dri-Fri."

Table 1 shows the data on the preparation of good quality chips and pea and lima bean nuggets and the relative stability or shelf life of the products.

Variety and maturity of the various vegetables were very important in their successful production and many experimental trials were made before the best conditions were found. A few of the more important factors should be mentioned.

All vegetables were thoroughly washed before cooking; beets, only, were peeled.

Beets: Small bunching beets (1½-2 in. diam.) gave bitter dark chips and so only larger starchy beets could be used.

Carrots: Carrot chips could not be made satisfactorily from the heavy cored types like Danvers or Nantes Half Long or Red Cored Chantenay since it was impossible to obtain uniform cooking of the core and cortex sections of the thick roots of these varieties. The long bunching types cooked to a uniform crispness in the time specified.

Parsnips: Only the one parsnip variety shown in the table was available, and this was entirely satisfactory for the preparation of parsnip chips. The size was not as important as with beets although commercial medium and large grades were preferred. Parsnips can be obtained in this area (New Jersey, New York, Pennsylvania) from mid-fall to late winter, those coming out of winter storage being as good for chips as fall roots. Roots

[c] The mention of commercial products is not to be construed as an endorsement by the U. S. Department of Agrciulture over other products not mentioned.

TABLE 1

Preparation of deep-fat fried vegetables

Vegetable	Variety used	Maturity	Average moisture content		Frying conditions		Time range	Average shelf life under standard storage conditions[1]
			fresh	after frying	thickness of slice	temperature		
			%	%	*inches*	° *F.*	*minutes*	*months*
Beets	Crosby's Egyptian, Early Wonder, Detroit Dark Red	Mature 2½-4 in. diam.	89.0	3.1	1/16	300	5-6	12
Carrots	Imperator or California Bunching	Any size, 1 in. to 1½ in. crown diam. preferred	89.0	3.3	1/16	275	5-6	2
Parsnips	Pa. Guernsey	Any size, 2-3 in. crown diam. preferred	78.0	2.5	1/32-1/16	275	3-4	12
Lima beans	Fordhook	Large overmature	63.0	3.9[2]	whole bean	300	9-10	12
	Henderson	Mature	65.0	1.8[2]	whole bean	300	8-9	12
Peas	Glacier	Large overmature	69.0	3.0[2]	whole pea	300	8-9	12-20
	Rainier	Large overmature	77.0	3.8[2]	whole pea	300	8-9	12-20

[1] See introduction under "Storage Studies."
[2] Embryo.

dug from the ground after freezing are a little sweeter and give a slightly browner chip which, nevertheless, is very tasty.

Parsnips showed some variation in density and it was necessary to try each lot experimentally to determine the best cut. One lot of roots of lower than average moisture content (73%) obtained during a very dry fall period had to be cut to 1/32 in. to give a crisp chip. A 1/16 in. cut gave a tough chip that did not break easily in the mouth. Most of the roots obtained from winter storage gave a satisfactory chip with a 1/16 in. cut.

Lima Beans: Both Fordhook and Henderson varieties of lima beans made satisfactory fried lima nuggets. The overmature Fordhook is greatly preferred and both extra large white or green beans, as rejected on the packing house sorting lines, made an excellent fried product. Since the amount of rejects is not too great at any one time a constant supply would have to be obtained by allowing the field beans to mature an extra few days before vining. Dried white limas (Butter Beans) could also be used for the preparation of French fried lima nuggets after a period of at least 12 hours of soaking prior to frying. These were a little harder than the nuggets prepared from the fresh beans and did not have the same fresh bean flavor. The shelled green beans required a 3-minute blanch in boiling water and a brief drain before frying so the seed coats could be removed by cooking and rubbing or brushing off in a manner similar to that used in removing the skins of peanuts.

Peas: When first tested, peas appeared to be about the most unlikely prospect for deep-fat frying of any of the vegetables examined. Our experimental studies of peas revealed one basic factor which must be observed, i.e., only hard starchy peas made successful French fried pea nuggets. When prepared from shelled fresh market pod peas those held on a No. 5 or 12/32 in. mesh screen gave a satisfactory fried product whereas those passing through this screen and held on a 9/32 in. screen were a mixture of mature and immature seeds. The immature seeds (those normally used for freezing and canning) were less starchy and contained too much sugar and moisture to be used for frying.

As with lima beans, freezing plant [4] rejects were kindly made available for our studies and peas showing tenderometer readings of 150 or over made excellent nuggets. Although more overmature peas than limas would normally be available at canning and freezing plants it is probable that growers could be induced to supply these peas from fields especially grown for this purpose along with those which often occur as hot weather surpluses. The overmature peas can be vined with less damage and hold better in storage than immature peas. After washing in cold water we have held them in 40° F. storage for 48 hours or longer without loss of quality in the finished product. Peas do not require blanching for seed coat removal since most of the skins come off during frying. In the case of the very ripe yellowing seeds they often pop off with considerable violence and the operator should be protected from hot oil by a screen. Peas like limas are more palatable when the seed coat is removed by mechanical action and only the whole embryo or separated cotyledons were used. Fried peas should be stored in light tight containers since light appears to catalyze the breakdown of the chlorophyll and carotenoid pigments giving a product of undesirable color having a hay like odor.

Centrifuging: Since vegetable chips must be prepared at temperatures of 275°-300° F. for slightly longer cooking times than potato chips, the absorption of oil is somewhat higher. We found that some of this oil could be removed by centrifuging in a basket type of centrifuge. Using a basket of 11 inches outside diameter and a maximum speed of 1500 r.p.m. for beet and 2000 r.p.m. for carrot and parsnip chips, the oil content could be reduced by 4-11% as shown in Table 2.

Salting and flavoring of chips and nuggets: All of the fried vegetable products were salted with fine chip salt after cooking and draining or centrifuging. Other flavored salts or flavoring agents were tried on the various preparations and their use would be a matter of individual preference. Celery, garlic, parsley salts and a savory salt with sage and other spices with monosodium glutamate were used. A smoked "bacon flavor" product [e] was also used on the chips.

Soup mixes from peas and lima beans. For the preparation of soup mixes, deep-fat dehydrated peas and lima beans were ground in a Wiley Mill to a fine powder (1 mm. mesh screen). Because of the high fat content of these peas and beans, it was necessary to cool them prior to grinding by placing them in a deep freeze unit or packing them in dry ice. It was also essential to cool the grinding mill and keep it cold with dry ice during the grinding. Some surface frosting occurred under humid conditions but this could be eliminated by allowing the powder to warm up in a 250° F. oven for a short period of time after the grinding. The resulting dry powder was free flowing and could easily be mixed with other ingredients or packed in containers for storage.

Ground peas made a tasty soup by simply adding 50 g. of powder to 250 ml. (approximately 1 cup) of boiling water and allowing the mixture to simmer (194° F.) for 3 minutes. We did not salt this plain soup mix, allowing our panel members their choice in this respect. A much more popular soup mix was made by premixing 7.5 g. of smoked "bacon flavor" powder [e] with the 50 g. of dehydrated pea powder before addition to the hot water. This mixture gave a delectable smoked ham flavor to the soup which compared favorably with the old time split pea soup made by cooking split peas for several hours with a good chunk of smoked ham.

Both the Glacier and Rainier peas made very acceptable soup mixes. Whole dehydrated peas (embryos and seed coats) as well as separated embryos could be ground for soups but it was the opinion of our taste panel members that a slight grittiness could be detected in the soups containing the seed coats.

We have been told by private communication that one of the objections to presently available precooked pea soup mixes is their fineness or nongranularity. A ready cure for this homogeneous condition would be to incorporate chunks of French fried peas in the mix. Since these chunks rehydrate to a soft particle, yet remain intact, they could be used to impart a sense of "feel" to the soup mix. We have added chunk size pieces (about 1/16 to 1/8 in.) to our fine ground soup mix and found this combination very satisfactory.

Ground lima beans, either plain or with "bacon" powder, were made into tasty soups by the addition of approximately 20% by weight of powder to hot water and simmering for three minutes.

Analysis of French fried vegetable products. Moisture determinations were made on the fresh vegetables by drying to constant weight in a Dietert Moisture Teller.[c] The moisture content of the fried products was determined in a Brabender [c] apparatus. Average moisture values on a number of samples of the fresh and dehydrated vegetables are shown in Table 1. Table 2 shows the average oil contents of these same samples. The values were obtained by the method of Williams and McComb *(6)* in which the chips were ground and repeatedly extracted with hot carbon tetrachloride then reground and extracted as before. The filtered extract was evaporated to dryness on a steam bath. The weight of the oil extracted from the fried vegetables is expressed as:

$$\frac{\text{Weight of oil} \times 100}{\text{Weight of Sample}} = \text{Percent oil in chips}$$

Table 2 also shows the yields of edible fried products obtained from the fresh vegetables. The yields of the peas and lima beans are based on the weights of the recovered embryo fractions rather than the embryo and seed coat. In column 7, however, which shows the amount of oil per 100 lbs. of fresh vegetable, both the embryos and seed coats are included since both remove a certain amount of oil from the cooking kettle.

We have not as yet made complete studies of nutritional values of French fried vegetable chips and pea and lima bean nuggets. These products are not proposed primarily as dietary items but rather as unusual snack items. They do, however,

[4] Seabrook Farming Corporation, Bridgeton, New Jersey. (cf.[e]).

[e] Dell Food Specialties Company, Beloit, Wisconsin. (cf.[e]).

TABLE 2

Analysis of deep-fat fried vegetables

Fat and protein contents, yields and fat consumption

Fried vegetable	Fat content		Protein		Yields	Fat used per 100 lbs. fresh vegetable
	after frying	after centrifuging	as is basis	fat free basis	based on fresh vegetable	
	%	%	%	%	%	*lbs.*
Beet chips	50	43	7.3	14.7	23	11.5
Carrot chips	51	40	2.9	6.0	23	12.0
Parsnip chips	47	43	5.5	10.4	43	20.2
Lima bean:						
Fordhook, fried embryo	27	....	19.1	26.1	38	11.3[1]
Henderson, fried embryo	31	....	16.1	23.4	41	15.0[1]
Peas:						
Glacier, fried embryo	33	....	22.0	32.8	34	14.5[1]
Rainier, fried embryo	38	....	22.5	36.3	21	12.3[1]

Protein contents of dehydrated lima beans and peas

	Oven dried					
Lima beans, Fordhook, dehydrated embryo	1.1		24.8	25.1		
Peas, Glacier dehydrated embryo	2.3		31.0	31.7		

[1] Embryo and seed coat.

offer certain dietary factors which should not be ignored in a consideration of their use. All are high in carbohydrate and oil and thus could serve as a quick energy food item. Carrot chips are exceptionally rich in carotene (provitamin A) and peas and lima beans are a concentrated source of protein comparable to oil seed products such as roasted peanuts and other nut products.

To determine how well carrots retained their vitamin A value we made a number of carotene assays by the method of Wall and Kelley *(4)* on both fresh and French fried carrot slices. Because of the high oil content of the chips, the foaming alcohol and petroleum ether method, as described for fresh plant materials, was found most satisfactory for chips. This was followed by saponification of the extract with 10% alcoholic KOH as described by Wall, Kelley and Willaman *(5)*.

Fresh carrots of 87.6% moisture content had a carotene value of 127.6 μ/g. on an "as is" basis and a value of 1025 μ/g. on a moisture free basis. French fried carrot slices showed 313 μ/g. of carotene on chips of 48.9% fat content or 639 μ/g. on a moisture and fat free basis. These figures show a loss of 38% of the carotene after frying at 275° F. Because of the concentration of the carrot slices during frying, the fried chips actually contained about 2½ times the amount of carotene of an equal weight of fresh carrots.

Protein values of the chips, peas and lima beans were found by determination of the total Kjeldahl N by the AOAC semi-micro Kjeldahl method *(3)*, as recently modified by Ogg *(2)*, on solvent extracted vacuum oven dried samples. The high oil content of these French fried products seriously interfered with the Kjeldahl nitrogen procedure and solvent extraction was essential to an accurate determination.

The samples were extracted with hot carbon tetrachloride as described above. Sixteen-hour Soxhlet extractions of the residues with ether yielded only 1.15% additional fat for the peas and 1.06% for the lima beans. This represents about ½ of the lipid content of the dehydrated peas and the full lipid content of the lima beans.

The protein contents of the 5 French fried vegetables are shown in Table 2. For comparison, Table 2 also shows the protein contents of dehydrated lima bean and pea embryos. It can be seen that there was no appreciable loss of protein during the frying of these two products.

The amino acids of these peas and lima beans are being studied and the results will be published at a later date.

DISCUSSION

In preparing new food items, such as those described in this paper, laboratory scale experiments serve primarily as an indication of what can be done in the way of preparing large quantities of new precooked foods. Evaluation of the particular group of products described above is uncertain at best. We have tried by using small taste panel groups (10-16 people) to determine the optimum conditions for preparation of the products. The only point on which all the panel members agreed was that the products should be crisp or even crunchy in the case of pea and lima bean products.

The optimum length of cooking time varied within narrow limits according to individual preferences. Some of the panelists like a slightly scorched or toasted flavor, whereas others preferred the stronger vegetable taste.

There was a considerable variation of opinion on the most desirable amount of oil in the chips and pieces. Some preferred the original oil content after frying while others felt that the removal of 5 to 8% of this oil by centrifuging was advisable.

Salting and flavoring of the products likewise occasioned numerous comments as a result of individual tastes. The general conclusion along this line was that most panelists preferred salty products but a few were satisfied with very small amounts. Carrot and parsnip chips were sweeter to the taste than the other products and, in general, required less salting or none at all as far as some tasters were concerned.

Finally, people vary greatly in their liking for fresh vegetables. It is doubtful, therefore, whether or not it is possible to obtain an unbiased opinion of the French fried products made from the 5 different vegetables. At the risk of prejudicing possible future consumers of these products, we are presenting a few overall comments on the 3 vegetable chips and the 2 nut like pea and lima bean chunks. These are summarized below. We have failed so far to find anyone who did not relish the French fried peas. When asked to compare the slightly more mature Glacier peas with the greener sweeter Rainier peas, there were individual preferences but if given either one alone they were consumed on the spot. Lima bean chunks were well liked by the majority of the tasters but a few considered them lacking in a distinctive flavor like the peas, and some found them harder in texture. The toasted flavor was somewhat preferred for the lima bean chunks.

Beet chips presented the greatest flavor problem. A few people refused them because of their intense dislike for beets as a vegetable. In contrast some true beet lovers consumed all the chips we could provide and even asked for more. In general, they were considered to have a slightly bitter after-taste which may well be due to their high concentration of organic acid salts. The deep red purple color of these beet chips was considered novel for cocktail use by many but a few felt that only light brown chips similar to potato chips would have sales appeal.

Carrot chips were likewise deeply colored but the orange color was not considered as novel by the color conscious tasters. The fresh carrot chip flavor was well liked but the stale taste of over-age chips was quickly detected by most tasters. It was evident to us that carrot chips could not be carried on store shelves for over 2 months.

Parsnip chips were well liked by the majority of our taste panel members in spite of the fact that many did not like parsnips as a cooked vegetable. More than half of our tasters were unfamiliar with this vegetable in any form. However, no prejudice toward the chips could be noted in either case. More often the first reaction was an expression of surprise that such a good product could be made from such an uncertain vegetable. The light golden brown color of the parsnip chips was considered satisfactory by the most discriminate color observers.

Large group tasting. The reactions of about 300 nontechnical people toward the three vegetable chips, beet, carrot and parsnip, were obtained at an open house meeting at this Laboratory. The general opinion was that the parsnip chips were the most tasty and unusual of the three but, as with the small taste panel groups, some favored beets and others, carrots. Most of the housewives asked when they could buy these products on the market. Many of the women were impressed with the vegetables in this new form and felt that they might be able to get their children to eat more vegetables if they could obtain these chips. Like potato chips, they might be a popular school or after school snack for the energy consuming youngsters.

The fried chips, peas and lima beans were also presented at a national meeting of potato chippers. Several hundred people tasted these products at that time and the majority of comments were favorable. Many of these individuals, associated with the food industry, felt that the fried vegetable products would do well as an accessory line for the potato chip manufacturer. A few others felt that they would be competitive.

SUMMARY

The greatly increased consumption of precooked foods in the last few years has stimulated research on the preparation of vegetables in a form comparable to potato chips.

Beet, carrot and parsnip slices have been cooked in deep fat to yield tasty and attractive vegetable chips. Peas and lima beans have been prepared as crunchy pieces having a nut like flavor and appearance.

Variety and maturity studies have been made on each vegetable to determine the conditions best suited to this type of processing. The best temperature and cooking time for each was likewise found. Of the five vegetables studied, only lima beans required blanching prior to frying.

When cooked in a stabilized oil, the fried vegetables are stable over long periods of time (6-12 months) at room temperature. Carrot chips are somewhat less stable than the other products due to their high carotene content. Although some loss of carotene occurred during the short period of cooking, enough remained to make these chips a rich source of this vitamin A precursor.

Fried pea and lima bean nuggets are rich in protein, fat and carbohydrates making them highly nutritious food items. They can be eaten as pieces, like nuts, or made into a spread by grinding. They can be converted to a fine powder by freeze grinding and, mixed with suitable flavoring ingredients, they make an excellent dry soup mix which can be fully rehydrated in about three minutes in hot water.

Beet, carrot and parsnip chips can be used as a precooked vegetable or for cocktail snacks. They are particularly tasty when salted with garlic, savory or other commercial flavoring salts or spices.

LITERATURE CITED

1. Now It's Sweet Potato Chips. *Potato Chipper,* 13, (5), 42 (1953).
2. Ogg, C. L. (Personal communication.)
3. Report on Standardization of Microchemical Methods. Micro Kjeldahl Nitrogen Determination. C. O. Willits, Referee and C. L. Ogg, Assoc. Referee. *J. Assoc. Offic. Agric. Chem.,* 33, 179 (1950).
4. Wall, M. E., and Kelley, E. G. Determination of Pure Carotene in Plant Tissue; A Rapid Chromatographic Method. *Ind. Eng. Chem., Anal. Ed.,* 15, 18 (1943).
5. Wall, M. E., Kelley, E. G., and Willaman, J. J. Carotene Concentrates from Vegetable Leaf Wastes. *Ind. Eng. Chem.,* 36, 1057 (1944).
6. Williams, K. T., and McComb, E. A. A Rapid Method for the Determination of Oil in Potato Chips. *Potato Chipper* 10, (9), 5 (1951).
7. 'Yambassadors' See Chips Made Out of La. Yams. *Produce News,* Sept. 10, 1954.